EDUCATION AND PRODUCTION

Air Velocity and High Temperature Effects on Broiler Performance[1]

B. D. LOTT,[2] J. D. SIMMONS, and J. D. MAY

USDA, Agricultural Research Service, South Central Poultry Research Laboratory, Mississippi State, Mississippi 39762

ABSTRACT Three trials, using a total of 1,320 male broilers, were conducted to study the effect of air velocity at 125 m/min on body weight gain and feed: gain. The broilers were placed on litter in pens in a wind tunnel or on litter in floor pens with conventional cross ventilation when 4 wk old. Except for air velocity, the conditions in the floor pens and the tunnel were the same. In Trials 1 and 2, only nipple waterers were used. In Trial 3, one-half of the pens on the floor and one-half of the pens in the tunnel were equipped with trough waterers; the remaining pens were equipped with nipple waterers. When compared with conventional ventilation, tunnel rearing improved body weight gain and feed:gain in all three trials. In Trial 3, waterer type did not significantly affect body weight gain or feed:gain in the tunnel. However, body weight gain and feed:gain were reduced in floor-reared birds using nipple waterers as compared with birds using trough waterers. The increased panting of the conventionally ventilated birds, as compared with the tunnel-ventilated birds, may have contributed to their decreased body weight gain and improved feed:gain. The lower body weights may occur because of the difficulty the birds experience when drinking from nipples while panting.

(*Key words*: tunnel, ventilation, broiler, weight, gain)

1998 Poultry Science 77:391–393

INTRODUCTION

Tunnel-ventilated poultry houses are replacing conventional, trough, curtain-sided houses in the southern U.S. Tunnel ventilation is an arrangement in which ventilating air is drawn into one end of the house and exhausted at the other end. The air velocity in a tunnel-ventilated house is greater than that in a conventional cross-ventilated arrangement with similar rates of air exchange. Lacy and Czarick (1992) noted improved weight gains of broilers in tunnel- vs cross-ventilated houses.

The use of tunnel ventilation probably originated from research done 30 yr ago. Drury (1966) noted increased weight gains as air velocity was increased over 7-wk-old birds. Similar results were obtained for birds 3 to 6 wk of age. Drury and Siegel (1966) observed that body temperatures did not stay elevated after a thermal stress for as long at high air velocities when compared with lower velocities. More recently, Mitchell (1985) showed that at 30 C, increasing wind speed increased sensible heat loss. Likewise, Timmons and Hillman (1993) observed that higher wind speeds increased sensible heat loss and reduced latent heat loss. Research by Simmons *et al.* (1997) demonstrated that air velocity did not affect total heat loss, but increasing the air velocity caused a shift from latent to sensible heat loss for temperatures between 29.5 and 35 C.

Recent data show that at high cyclic temperatures, water consumption and weight gains are lower for a nipple watering system than for an open watering system (May *et al.*, 1997). An open watering system consists of bell, trough, or cup; but nipple watering systems are being installed in most new poultry houses. McMasters *et al.* (1971) observed no differences in body weight, feed efficiency, or mortality with nipple systems as compared with trough systems. Most of the earlier air velocity work with poultry was done with a trough watering system. Vest (1986) reported that producers using nipple waterers had improved feed conversion and similar body weights compared with those using a trough watering system. Carpenter *et al.* (1992) suggested that during hot weather, nipple drinkers with increased flow rate improved broiler performance when compared to nipple drinkers with lower flow rates. The objectives of this research were to determine the effects of air velocity and waterer type on growth and feed conversion of broilers at warm temperatures.

MATERIAL AND METHODS

Trials 1 and 2

Each trial was conducted with 440 male broiler chickens. The chicks were obtained from a commercial hatchery and reared in an environmentally controlled

Received for publication April 11, 1997.
Accepted for publication October 21, 1997.

[1]Trade names in this article are used solely to provide specific information. Use of trade names does not constitute a guarantee or warranty by USDA and does not signify that the product is approved to the exclusion of other comparable products.

[2]To whom correspondence should be addressed: blott@ag.gov

TABLE 1. Temperatures and starting dates for each trial

Trial	Starting date	Temperature Minimum	Average	Maximum
		(C)		
1	2-22-96	25.7	28.2	31.8
2	4-30-96	26.1	28.5	32.8
3	6-18-96	26.1	30.3	35.6

house with normal brooding practices until they were 4 wk old. Corn:soybean meal diets formulated to meet or exceed National Research Council (1994) requirements were provided to all chickens. The starter diet that was provided until 3 wk contained 3,150 ME/kg with 1.15 and 0.88% lysine and sulfur amino acids, respectively. A finisher diet that was provided for the remainder of the trials contained 3,200 ME/kg with 1.03 and 0.83% lysine and sulfur amino acids, respectively. The starter feed was in crumble form and the finisher diet was pelleted. When the chickens were 4 wk old, they were separated into eight groups, and the average body weights of the groups were equated. Four groups were placed in floor pens and four groups were placed in pens within the tunnel. A detailed description of the tunnel has been reported by Simmons *et al.* (1997).

Fifty chickens were placed in each 1.5 × 3.0 m floor pen, and 60 chickens were placed in each 1.2 × 4.25 m pen in the tunnel. Temperature, light intensity, bird density, and distance to a feeder and waterer were as equal as possible between the tunnel and floor pen. Nipple waterers with uninsulated lines were used; the height of the nipples from the floor and the head pressure were adjusted according to manufacturers' recommendation. The water output per nipple averaged 45 mL/min with eight nipples per pen. The tunnel and floor pens were inside the same poultry house (11 × 55 m), which had mechanical thermostats set at 28 C. The temperature in the house was essentially the same as the outside temperature when above 28 C because the house was not equipped with mechanical cooling. Air exited the tunnel within the house at the opposite end of the house from the floor pens and the tunnel entrance. The air that had passed through the tunnel was exhausted from the tunnel and mixed with the air in the house. Therefore, the air was recycled and additional fans were used to mix the air in the house. The house was also equipped with minimum ventilation and high temperature fans. The air inlet for the tunnel was 3 m from the closest floor pen. The air velocity within the tunnel was maintained at a constant 125 m/min. The incidental air velocity over the birds reared on the floor was recorded as 15 m/min.

Ambient temperature and air velocity in the tunnel were measured and recorded every 30 min. Body weights and feed data were collected at 6 wk of age. Mortality was recorded daily.

Trial 3

The experimental procedure was the same as for Trial 1 and 2 except for the waterers. In Trial 3, two floor pens and two tunnel pens were equipped with trough waterers (2.6 m in length) instead of nipple waterers.

A completely random design was used. The data were analyzed using the General Linear Models procedure for analysis of variance (SAS Institute, 1994). Significant differences among treatments means were identified using Duncan's new multiple range test (Duncan, 1955) at $P \leq 0.05$.

RESULTS AND DISCUSSION

The data presented in Table 1 report the temperature variation that existed within each trial. Trials 1 and 2 were similar in temperature, but the temperature in Trial 3 was warmer than that of the other trials.

Body weight gains and feed:gain for Trials 1 and 2 are presented in Table 2. Chickens reared in the tunnel gained significantly more weight from 4 to 6 wk of age than the chickens reared in the floor pens. The chickens reared in the tunnel consumed approximately 300 g more feed than the floor-reared chickens in Trials 1 and 2. Also, there was a significant improvement in feed: gain for the chickens reared in the tunnel. It was noted that the chickens in the tunnel did not exhibit any panting (Trials 1 and 2), but that the chickens in the floor pens panted heavily during the warm part of the day. Previously, May *et al.* (1997) demonstrated a significant reduction in water consumption by chickens consuming water from nipple waterers when compared with those consuming water from an open watering system during the elevated temperature part of a 21-35-21 C diurnal cycle.

TABLE 2. The effect of air velocity on weight gain (WG) and feed conversion (FC) of 4- to 6-wk-old male broilers, Trial 1 and 2

Air velocity	Trial 1 WG	Trial 1 FC	Trial 2 WG	Trial 2 FC	Trials combined WG	Trials combined FC
(m/min)	(g)	(g:g)	(g)	(g:g)	(g)	(g:g)
15	978[a]	2.08[a]	1,078[a]	2.14[a]	1,028[a]	2.11[a]
125	1,259[b]	1.96[b]	1,250[b]	1.97[b]	1,255[b]	1.97[b]

[a,b]Values within columns with no common superscript differ significantly ($P \leq 0.05$).

TABLE 3. The effect of air velocity on weight gain (WG) and feed conversion (FC) of 4- to 6-wk-old male broilers, Trial 3

	Trough		Nipple		Average	
Air velocity	WG	FC	WG	FC	WG	FC
(m/min)	(g)	(g:g)	(g)	(g:g)	(g)	(g:g)
15	745[a]	2.57[a]	533[a]	3.15[a]	639[a]	2.86[a]
125	1,119[b]	2.05[b]	1,151[b]	2.01[b]	1,135[b]	2.03[b]

[a,b]Values within columns with no common superscript differ significantly ($P \leq 0.05$).

In Trial 3, both trough and nipple watering systems were used in the tunnel and floor pens. The body weight and feed data are presented in Table 3. We noted no significant difference in body weight due to waterer type in the tunnel with an air velocity of 125 m/min. The chickens reared in the floor pens had significantly reduced body weight gains when compared with the chickens reared in the tunnel. With the reduced body weight gain, there was a corresponding increase in the feed:gain. We observed a decrease in body weight gain with the nipple watering system vs the trough waterer system. This reduction was attributed to the reduction in water consumption due to the chickens panting at the higher temperature, as suggested by May *et al.* (1997). The reduction in water consumption caused a decrease in feed consumption and a corresponding reduction in body weight gain.

The reduced panting in tunnel-reared chickens suggests a shift in the methods of heat dissipation by the bird. Simmons *et al.* (1997) noted a shift from latent to sensible heat with increasing air velocities. The most efficient method of removing heat from the bird is by sensible heat at higher environmental temperatures. Therefore, the air velocity of 125 m/min used with the tunnel-reared chickens causes the shift from latent to sensible heat dissipation and may be the reason that the tunnel-reared chickens had improved weight gain and feed:gain when compared with the birds reared on the floor pens.

ACKNOWLEDGMENTS

The authors wish to thank Mike Lacy and James Donald for their critical review in the preparation of this manuscript.

REFERENCES

Carpenter, G. H., R. A. Peterson, W. T. Jones, K. R. Daly, and W. A. Hypes, 1992. Effects of two nipple drinker types with different flow rates on the productive performance of broiler chickens during summer like growing conditions. Poultry Sci. 71:1450–1456.

Drury, L. N., 1966. Air velocity and broiler growth indiurnally cycled hot environment. Trans. ASAE 9:329–332.

Drury, L. N., and H. S. Siegel, 1966. Air velocity and heat tolerance of young chickens. Trans. ASAE 9:583–585.

Duncan, D. B., 1955. Multiple range and multiple F tests. Biometrics 11:1–42.

Lacy, M. P., and M. Czarick, 1992. Tunnel-ventilated broiler houses: broiler performance and operating cost. J. Appl. Poult. Res. 1:104–109.

May, J. D., B. D. Lott, and J. D. Simmons, 1997. Water consumption by broilers in high cyclic temperatures: bell vs. nipple waterers. Poultry Sci. 76:944–947.

McMasters, J. D., Jr., G. C. Harris, Jr., and T. L. Goodwin, 1971. Effects of nipple and trough watering system on broiler performance. Poultry Sci. 50:432–435.

Mitchell, M. A., 1985. Effects of air velocity and convective and radiant heat transfer from domestic fowls at environmental temperatures of 20 and 30 C. Br. Poult. Sci. 26:413–423.

National Research Council, 1994. Nutrient Requirements of Poultry. 9th rev. ed. National Academy Press, Washington, DC.

Simmons, J. D., B. D. Lott, and J. D. May, 1997. Heat loss from broiler chickens subjected to various wind speeds and ambient temperatures. Appl. Eng. Agric. 13(5):665–669.

SAS Institute, 1994. SAS® Users Guide. 1994 Edition. SAS Institute Inc., Cary, NC.

Timmons, M. B., and P. E. Hillman, 1993. Partitional heat losses in heat stressed poultry as affected by wind speed. 4th International Livestock Environment Symposium, London, England, July 1993. ASAE Special Publication, St. Joseph, MI.

Vest, L. R., 1986. Management of closed water systems for poultry. Poultry Sci. 65(Suppl. 1):139. (Abstr.)